

# The Beta-Delayed Proton Decay of $^{23}\text{Si}$

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The relationship between mass and binding energy makes the ground state mass one of the most interesting features of nuclei. Predictions of masses serve as a stringent test of the various mass models. One method that may be used to accurately estimate ground-state (g.s.) masses of proton-rich nuclides involves measuring  $\beta$ -delayed proton emission through the isobaric analog state (IAS) of the nuclide of interest. The  $\beta$ -decay branch to this state is favored due to its similarity to the initial state; the two are related simply through the Coulomb displacement energy (CDE) [1]. We have used this approach to determine the g. s. mass of  $^{23}\text{Si}$ .

$^{23}\text{Si}$  was produced in the 110 MeV  $^3\text{He}$  bombardment of  $^{24}\text{Mg}$  targets. Reaction products were transported by He-jet to a shielded counting station, where they were deposited on a slowly rotating catcher wheel. The unusually-large proton energy ( $\sim 11$  MeV) predicted for  $\beta$ -delayed proton decay from the  $^{23}\text{Si}$  IAS in  $^{23}\text{Al}$  to the g. s. of  $^{22}\text{Mg}$  would act as a signature for this decay, permitting the measurement to be made without mass separation of the reaction products. Two specially designed particle-identification telescopes measured particle decays; they were similar in design to those in Ref. 2, but employed a single gas  $\Delta E$  detector, a second, 300  $\mu\text{m}$  Si  $\Delta E$  detector and a 600  $\mu\text{m}$  Si E detector, allowing proton energies of up to  $\sim 13$  MeV to be measured. The 88" Cyclotron beam was pulsed to eliminate fast-neutron-induced events during counting. Calibration was performed *in situ* from  $^{22}\text{Al}$ ,  $^{25}\text{Si}$  and  $^{21}\text{Mg}$   $\beta$ -delayed protons produced in this reaction, using the method in Ref. 2.

Figure 1 shows the proton spectrum that resulted. Two of the labelled peaks, at 7839 and 8149 keV are from the  $\beta$ -delayed proton decay of  $^{22}\text{Al}$ . A scattering of events is seen up to  $\sim 12$  MeV, including several possible peaks; three of them have energies of 10.83, 9.64 and 7.67 MeV. Though the paucity of events and the

"background" prevent a definitive assignment, these energies agree with the energies expected for decay to the g. s. and first two excited states of  $^{22}\text{Mg}$ . We calculate a  $^{23}\text{Si}$  g. s. mass of 23.12 MeV from the CDE and the center of mass proton energy.

Blank *et al.*, have recently published a measurement of the  $\beta$ -delayed one and two proton decay branches of  $^{23}\text{Si}$  using mass analysis [3]. Their result is compared to our result and to various mass predictions [4] in Table 1.

## Footnotes and References

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1. M. Antony, *et al.*, At. Data Nuc. Data Tab. **66**, 1 (1988).
2. M. Rowe, *et al.*, NIM **A397**, 292 (1997).
3. B. Blank, *et al.*, Z. Phys. **A357** 247 (1997).
4. P. Hausteint, At. Data Nuc. Data Tab. **39**, 185 (1988).

Table 1-- The mass of $^{23}\text{Si}$	Mass Excess (MeV)
Pape-Antony	23.44
Möller-Nix	23.86
Comay-Kelson-Zidon	23.51
Janecke-Masson	23.43
Wapstra-Audi	23.77
Blank <i>et al.</i>	23.42
This work	23.12

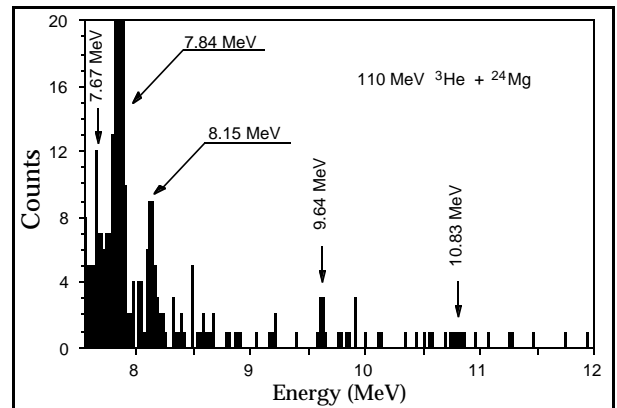


Fig. 1. High-energy  $\beta$ -delayed proton spectrum.